RESEARCH BULLETIN 977 DECEMBER 1965

Tyrophagus neiswanderi, A New Acarid Mite of Agricultural Importance

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12-65-3M

Tyrophagus neiswanderi, A New Acarid Mite of Agricultural Importance[1, 2] (Acari-Acaridei)

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Mites of the genus *Tyrophagus* are the most ubiquitous of Acari. They may be encountered in stored food products, farmyards, mosses, litter, humus and soil, higher fungi, roots of plants, and nests of mammals, birds and social insects. The group is virtually cosmopolitan in distribution.

One of the most unusual situations in which *Tyrophagus* has been found is on the aerial parts of higher plants where the mites were actually feeding on the tissues of the plant. This phenomenon was first brought to the authors' attention by Dr. R. B. Neiswander, who observed *Tyrophagus* feeding on foliage of greenhouse cucumbers in northern Ohio. In three of the four instances observed by Dr. Neiswander, a new species of *Tyrophagus* was involved.

This bulletin describes this species and summarizes the current taxonomy of the genus *Tyrophagus,* with special emphasis on forms of agricultural interest.

TYROPHAGUS NEISWANDERI **NEW SPECIES**[3]

Male (holotype). Idiosoma 413 microns in length (from level of internal vertical setae to posterior margin of notogaster). Idiosomal chaetotaxy normal. Measurements of dorsal setae as follows (in microns): d_1 43; d_2 63; *la* 40; d_2/la 1.58.

Supracoxal seta *elc I* (pseudostigmatic hair of authors) narrowly lanceolate, setulose, distally attenuate (*putrescentiae* type) (Fig. 1B).

Aedeagal supporting sclerites curved laterad (Fig. 1A). Aedeagus relatively small, with one major curve, distal end straight or nearly so (described from paratypes, Fig. 3D). Distance between basal element of genitalia and anal groove much less (13 microns) than length of anal groove (65 microns).

[1]Scientific Paper No. 137, Institute of Acarology, Department of Zoology and Entomology, Ohio Agricultural Research and Development Center, Wooster, Ohio.

[2]Based on work supported in part by National Science Foundation Grant G-19325.

[3]The authors take pleasure in naming this mite for its discoverer, Dr. Ralph B. Neiswander, Professor Emeritus of Zoology and Entomology, Ohio Agricultural Research and Development Center.

Tarsus I 68 microns in length. *omega*$_1$ long; not enlarged at tip. Famulus (*eta*) short, stout (Figs. 1C, 4A). *ba, aa, and omega*$_1$ not in line. Tarsus IV (Fig. 1D): $a + b$ 48 microns; c 30 microns; $a + b/c$ 1.6. Combined length of genu and tibia IV subequal to length of tarsus IV. Chaetotaxy of legs normal.

Chelicerae and subcapitulum normal. Supracoxal seta (*elc p*; maxillary seta of Zakhvatkin) short, broad, smooth (*putrescentiae* type).

Holotype ex laboratory culture originating from specimens found feeding on cucumber plants in a commercial greenhouse, Olmstead Falls, Ohio, on May 1, 1964; R. B. Neiswander, collector (sample No. 583); deposited in U. S. National Museum.

Other males studied were from sample No. 583 and from another collection as follows:

Numerous specimens feeding on cucumber plants and in peanut hull litter surrounding plants, Botany greenhouse, Ohio Agricultural Research and Development Center, Wooster, Ohio, on April 1, 1963; D. E. Johnston and J. H. Gregory collectors (sample Nos. 433, 434).

Variation in males. Given below are statistics derived from measurements of several attributes of males from the type series. These are arranged as follows — attribute: mean ± standard error; coefficient of variability; range; number of observations.

Sample 583					
d_1:	31.6	± .81;	12.0;	25-40;	22
d_2:	47.1	± .83;	7.6;	38-52;	19
la:	33.4	± .60;	10.5;	29-43;	34
d_2/la:	1.44	± .03;	8.5;	1.2-1.7;	18
$a + b$:	42.8	± .73;	8.2;	35-52;	23
c:	23.0	± .57;	11.9;	18-27;	23
$a + b/c$:	18.6	± .51;	13.1;	1.5-2.6;	23
Samples 433, 434					
d_1:	40.1	± .81;	12.6;	29-48;	39
d_2:	65.7	± 2.1 ;	15.1;	48-81;	22
la:	42.3	± .91;	14.5;	28-51;	46
d_2/la:	1.58	± .04;	10.9;	1.4-2.0;	16
$a + b$:	51.0	± .50;	6.4;	43-63;	43
c:	27.4	± .57;	13.6;	13-35;	43
$a + b/c$:	19.2	± .80;	27.3;	1.5-4.8;	43[4]

[4]Some of the statistics for **a + b, c,** and **a + b/c** for this sample are greatly affected by the inclusion of one otherwise 'normal' male with the following measurements: **a + b** 63, **c** 13, **a + b/c** 4.85. The ranges of **a + b, c,** and **a + b/c** for the other 42 specimens are 43-58, 20-35, and 1.5-2.4, respectively.

Female illustrated in Fig. 2. Measurements of dorsal setae of females from two samples are as follows:

Sample 583

d_1:	41.3 ± 1.8 ;	16.6;	33-63;	15
d_2:	64.6 ± 1.7 ;	10.4;	51-76;	15
la:	38.6 ± 1.2 ;	12.2;	33-48;	15
d_2/la:	1.72 ± .06;	10.8;	1.5-2.1;	11

Samples 433, 434

d_1:	51.0 ± .66;	11.5;	35-63;	79
d_2:	85.7 ± 1.8 ;	11.2;	73-119;	27
la:	51.1 ± 5.6 ;	9.7;	40-68;	80
d_2/la:	1.71 ± .12;	31.3;	1.5-2.2;	21

Egg. Ornamentation of chorion of the *longior* type; patterns of *T. neiswanderi* and *T. putrescentiae* illustrated in Figs. 4E and 4F.

Tyrophagus neiswanderi differs from previously described species of the genus in the combination of states of the following characters: relative lengths of dorsal setae d_1, d_2, and *la;* form of the aedeagus; form of the aedeagal supporting sclerites; relative position of the tarsal discs in the male; form and length of $omega_1$; form of the supracoxal seta (*elc I*); and the ornamentation of the chorion.

In the keys of Robertson (4) and Samsinak (6), *T. neiswanderi* runs to *T. javensis.* Samsinak has figured the neotype of this species. *T. neiswanderi* differs from those figures in the shape of the aedeagus and $omega_1$. Of the common species of *Tyrophagus* (*longior, mixtus, palmarum, perniciosus, putrescentiae*, and *similis*) likely to be encountered by applied acarologists and entomologists, *T. putrescentiae* and *T. palmarum* seem to be those most easily confused with *T. neiswanderi.* From *T. putrescentiae,* the new species differs in the shape of the aedeagus and supracoxal seta, dorsal setal pattern, and ornamentation of the chorion (compare Figs. 3B, 3D; 3G, 3I; 4A, 4B). From *T. palmarum,* it differs in the form of the aedeagal supporting sclerites (curved mediad in *palmarum* and laterad in *neiswanderi*).

Material examined. In addition to the collections cited above (samples 433, 434, and 583), the following material of *T. neiswanderi* has been seen:

Several adults feeding on cucumber plant in greenhouse near Cleveland, Ohio, February 1958 (reported by Neiswander (3) as *Tyrophagus* sp.).

Several adults and immatures on Carnation culture fungus, Farmingdale, New York, February 17, 1956; G. V. Johnson collector.

Observations on the biology of *Tyrophagus neiswanderi*. The mites from samples 433 and 434 are described here. Similar observations were made on the samples of 1958 and 1964.

The infestation observed in the Botany greenhouse at the Ohio Agricultural Research and Development Center originated from peanut hull litter with which the mites were apparently introduced. The litter had been in place for about 1 month. The mites were extremely abundant and were seen crawling from the litter up the stems of the plants. The greatest number of mites was on the young leaves; others were generally distributed over the plant. Only adults and eggs were seen on the plants. Numerous small holes (up to 4 mm in diameter) were seen in the leaves where feeding by *T. neiswanderi* had occurred. There is no question that this mite was responsible for the feeding damage. Feeding on detached leaves was easily observed with a dissecting microscope and the course of the ingested food within the bodies of these translucent mites could be readily followed.

In the laboratory, *T. neiswanderi* was cultured on a plaster of paris-charcoal substrate with wetted, activated yeast as food. These cultures were never as successful as similar ones of *T. putrescentiae*. Experiments to determine proper conditions for *T. neiswanderi* were not undertaken. In one instance, an invasion from a neighboring culture of *T. putrescentiae* quickly wiped out *T. neiswanderi*.

TAXONOMY OF THE GENUS TYROPHAGUS

Tyrophagus is a difficult genus. This difficulty lies in the homogeneity of exoskeletal anatomy within the genus and in the lack of heteromorphic deutonymphs, or hypopi, which in other genera provide so many useful characters. As larger samples become available, however, it should be possible to characterize at least some kinds of *Tyrophagus* with a fair degree of precision. This precision in identification will permit more sophisticated studies of species of interest. The remainder of this paper summarizes current knowledge of the taxonomy of the genus *Tyrophagus.*

Following is a list of the currently recognized species of *Tyrophagus* based on the recent reviews of Robertson (4) and Samsinak (6). Also listed are synonyms of the valid species and various misidentifications found in the comprehensive works of Zakhvatkin (11), Turk and Turk (8), and Hughes (1). References to these misidentifications are included to facilitate the use of these major works.

SPECIES OF TYROPHAGUS OUDEMANS

1. ***brevicrinatus* Robertson, 1959**
2. ***formicetorum* Volgin, 1948**
   Tyrophagus vjatscheslavi Sorokin, 1952
3. ***javensis* (Oudemans, 1916)**
4. ***longior* (Gervais, 1844)**
   Tyroglyphus infestans Berlese, 1884
   Tyroglyphus dimidiatus forma *humerosus* Oudemans, 1924
   Tyrophagus tenuiclavus Zakhvatkin, 1941
5. ***miripes* Athias-Henriot, 1961**
6. ***mixtus* Volgin, 1948**
7. ***molitor* Zakhvatkin, 1941**
8. ***neiswanderi* n. sp.**
9. ***palmarum* (Oudemans, 1924)**
   Tyrophagus viviparus Oudemans, 1926
   Tyrophagus parvulus Volgin, 1949
10. ***perniciosus* Zakhvatkin, 1941**
11. ***putrescentiae* (Schrank, 1781)**
    Tyroglyphus lintneri Osborn, 1893
    Tyroglyphus americanus Banks, 1906
    Tyroglyphus longior var. *castellanii* Hirst, 1912
    Tyroglyphus australasiae Oudemans, 1916
    Tyroglyphus muscae Sasaki, 1921
    Tyrophagus muris Oudemans, 1924
    Tyrophagus vanheurni Oudemans, 1924
    Tyrophagus amboinensis Oudemans, 1925
    Tyrophagus bulleri Volostschuck, 1936
    Tyrophagus noxius Zakhvatkin, 1936
    Tyroglyphus longior var. *taiwanensis* Sugimoto, 1938
    Tyroglyphus nadinus Lombardini, 1944
    Tyrophagus brauni Turk and Turk, 1957
    Tyrophagus dimidiatus, (Hermann) *in* Turk and Turk, 1957
12. ***silvester* Zakhvatkin, 1941**
    Tyrophagus humerosus silvester Zakhvatkin, 1941

13. ***similis* Volgin, 1949**

Tyrophagus humerosus, Oudemans *in* Zakhvatkin, 1941
Tyrophagus infestans, (Berlese) *in* Turk and Turk, 1957
Tyrophagus oudemansi Robertson, 1959
Tyrophagus dimidiatus, (Hermann) *in* Hughes, 1961

14. ***tropicus* Robertson, 1959**

15. ***zachvatkini* Volgin, 1948**

Tyrophagus vjatshensis Sorokin, 1952

As did Samsinak (6), the authors exclude from *Tyrophagus* the following: *Tyrolichus casei* Oudemans, 1910 (*Tyrolichus*); *Tyroglyphus neotropicus* Oudemans, 1917 (*Povelsenia*); *Tyroborus lini* Oudemans, 1924 (*Tyrolichus*); *Forcellinia fungivora* Oudemans, 1932 (*Mycetoglyphus*); and *Tyrophagus rotundus* Turk and Turk, 1957 (*? Acotyledon*).

In addition to the species listed, several unrecognizable forms have been assigned to *Tyrophagus.* These are: *Acarus dimidiatus* Hermann, 1804; *Tyroglyphus breviceps* Banks, 1906; *Tyroglyphus cocciphilus* Banks, 1906; *Tyroglyphus sacchari* Banks, 1917; *Tyroglyphus deliensis* Oudemans, 1923; and *Tyrophagus humerosus tesquorum* Zakhvatkin, 1941.

An introduction to the literature on the biology of *Tyrophagus* spp. may be found in the works of Zakhvatkin (11), Hughes (1), Robertson (5), and Kevan and Sharma (2).

Below is a translation (with some modifications) of Samsinak's (6) key to the species of *Tyrophagus.* To facilitate identification of species of special interest in agriculture, comparative figures of the aedeagi, dorsal setae, and *omega*$_1$ of these species are provided (Figs. 3A-3E, 3F-3I, 4A-4D). Because of reliance on relative lengths of the dorsal setae, couplets 3 and 4 of this key are rather weak. It has been noted that the dorsal setal patterns of males fit the criteria of the key better than those of females and therefore identifications are best based on males. It is likely that identification of females will be impossible in many cases.

KEY TO THE SPECIES OF TYROPHAGUS

Translated and modified from Samsinak (6)

1. *la* approximately twice as long as d_1. Distance between d_2 large (usually two-thirds the distance between d_1). Aedeagus short, arched. Supporting sclerites of aedeagus turned mediad. Supracoxal seta lanceolate, with long setules; distal portion attenuate. Africa, New Guinea . . . . ***tropicus* Robertson**

   la shorter or only slightly longer than d_1 2
2. d_2 well over five times as long as d_1. Supracoxal seta densely setulose. Aedeagus short, beak-shaped. Placement of discs on tarsus IV of male dividing segment into three almost equal parts. Algeria . . . . ***miripes* Athias-Henriot**

   d_2 at most five times as long as d_1. Supracoxal seta usually sparsely setulose or smooth 3
3. d_2 considerably (2.5-4.5 times) longer than d_1 4

   d_2 at most twice as long as d_1 7
4. d_2 3-4.5 times longer than d_1 or *la*. Aedeagus short, thickened distally and terminated obliquely 5

   d_2 2.5-3 times longer than d_1 or *la*. Aedeagus longer, narrowed distally and usually S-shaped (Fig. 3B) 6
5. d_2 displaced anteriad, placed about at level of h_1 so that tips of d_1 reach bases of d_2. Aedeagus thick, slightly S-shaped. Myrmecophilous. U.S.S.R., Czechoslovakia . . . . ***formicetorum* Volgin**

   d_2 in usual position in middle of idiosoma so that tips of d_1 do not reach their bases. Aedeagus arched. U.S.S.R., Europe, Australia . . . . ***perniciosus* Zakhvatkin**
6. *omega*$_1$ widened distally (slightly claviform) (Fig. 4B). Supracoxal seta lanceolate, densely set with long setules, very attenuate distally. Aedeagus S-shaped (Fig. 3B). Aedeagal supporting sclerites turned laterad. Cosmopolitan (?) . . . . ***putrescentiae* (Schrank)**

   omega$_1$ rod-shaped, not widened distally. Supracoxal seta not lanceolate. Aedeagus only slightly S-shaped. Aedeagal supporting sclerites turned mediad. Europe, New Zealand . . . . ***palmarum* (Oudemans)**
7. *omega*$_1$ long, thin, tapered distally (Fig. 4D). d_2 1.3-2 times as long as d_1 (Fig. 3H). Aedeagus long, thin, clearly S-shaped (Fig. 3A). Aedeagal supporting sclerites turned mediad. Europe, Asia, New Zealand, North America . . . . ***longior* (Gervais)**

   omega$_1$ not tapered distally (comp. Figs. 4A-C) 8

8. Supracoxal seta very short and entirely smooth. d_1, d_2, and *la* almost equal in length (*ca.* 40 microns). Aedeagus straight basally, curved distally. Aedeagal supporting sclerites turned laterad. Ghana . . . . ***brevicrinatus* Robertson**
Supracoxal seta always setulose 9

9. *la* slightly but definitely shorter than d_1. Aedeagus long, *narrow* (similar to that of *T. longior*). Supracoxal seta not lanceolate. Myrmecophilous. U.S.S.R., Czechoslovakia . . . . ***zachvatkini* Volgin**
la longer than d_1 10

10. d_2 twice or almost twice as long as d_1 (Fig. 3I). Aedeagus S-shaped. Supracoxal seta lanceolate, setulose, and distally attenuate 11
d_2 about as long as d_1 (Fig. 3F) 12

11. *omega*$_1$ widened distally (claviform). Aedeagus S-shaped. Myrmecophilous (?). Java . . . . ***javensis* (Oudemans)**
omega$_1$ rod-shaped, not claviform (Fig. 4A) Aedeagus with distal half straight (Fig. 3D). U.S.A. . . . . ***neiswanderi* n. sp.**

12. Supracoxal seta lanceolate, with long setules, and very attenuate distally. Placement of discs of tarsus IV of male dividing segment into three almost equal parts. Aedeagus short, arched or almost straight, and with rounded tip. Aedeagal supporting sclerites turned mediad. U.S.S.R. . . . . ***molitor* Zakhvatkin**
Supracoxal seta not lanceolate. Tarsal discs of male almost always in basal half of tarsus 13

13. Aedeagus slender, narrowed distally, and clearly S-shaped (Fig. 3E). U.S.S.R., Czechoslovakia, U.S.A. . . . . ***mixtus* Volgin**
Aedeagus not narrowed distally 14

14. Aedeagus stout, broadened distally, and almost straight in apical half (Fig. 3C). Supracoxal seta with long setules. U.S.S.R., Europe, North America, Australia . . . . ***similis* Volgin**
Aedeagus cylindrical, curved in apical half. Supracoxal seta with short setules. U.S.S.R., Czechoslovakia . . ***silvester* Zakhvatkin**

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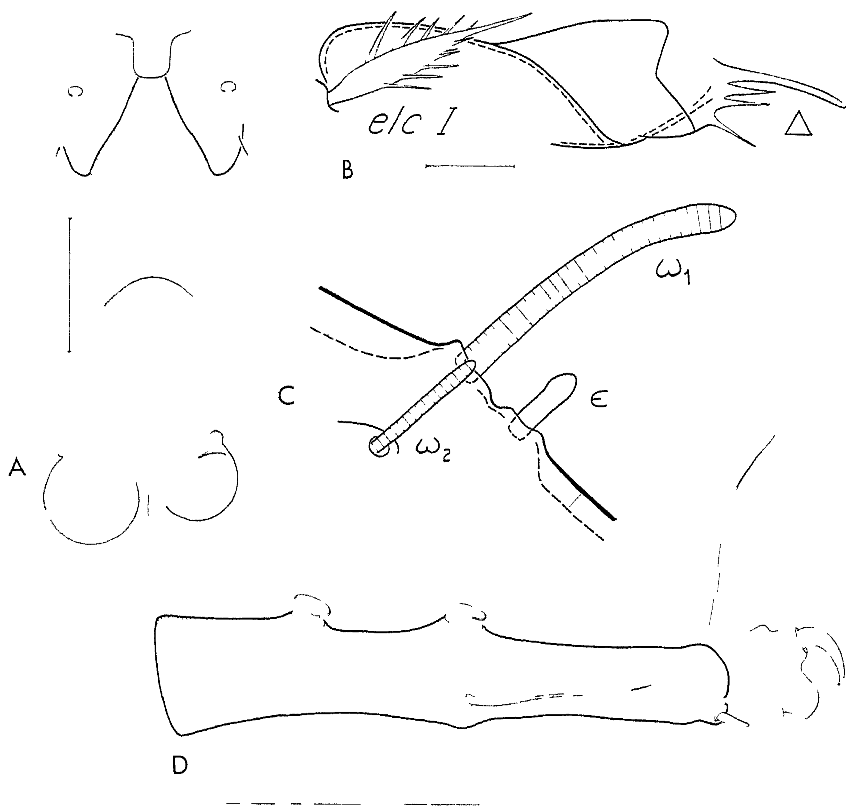

Fig. 1.—*Tyrophagus neiswanderi*. **A.** Genitoanal region of male. **B.** Supracoxal region of leg I of male. **C.** *omega*$_1$, *omega*$_2$, and famulus of tarsus I of male. **D.** Tarsus IV of male, posterior (paraxial). **A** and **D** scale equals 50 microns. **B** scale equals 10 microns.

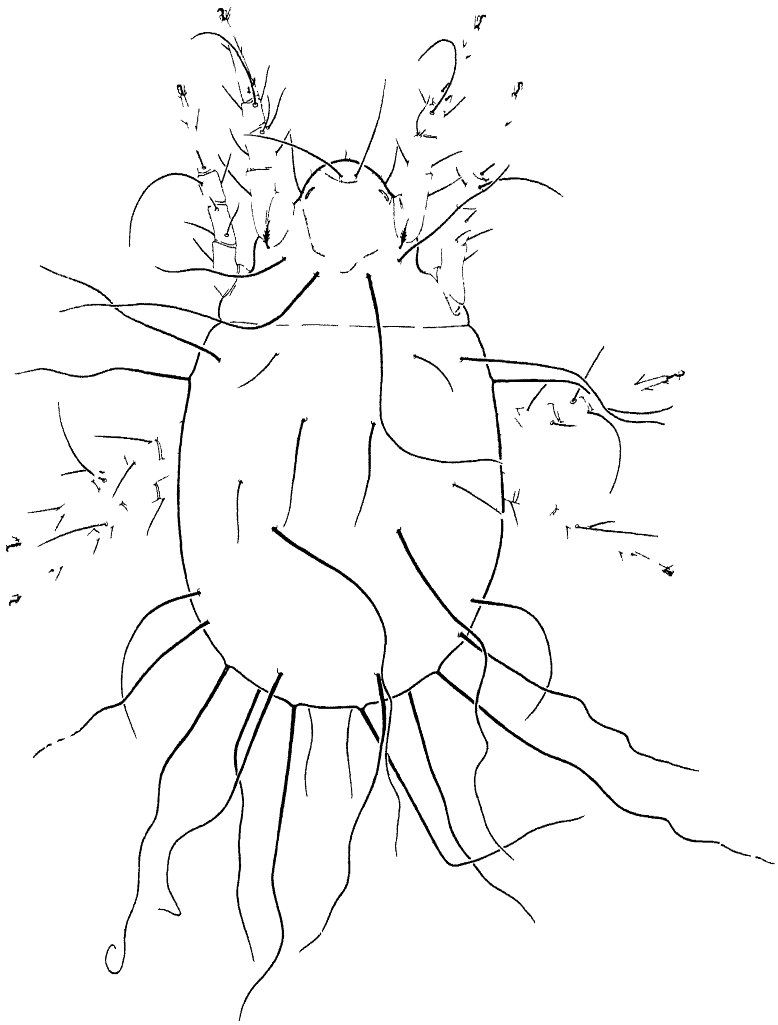

Fig. 2.—*Tyrophagus neiswanderi,* dorsal view of female. Scale equals 150 microns.

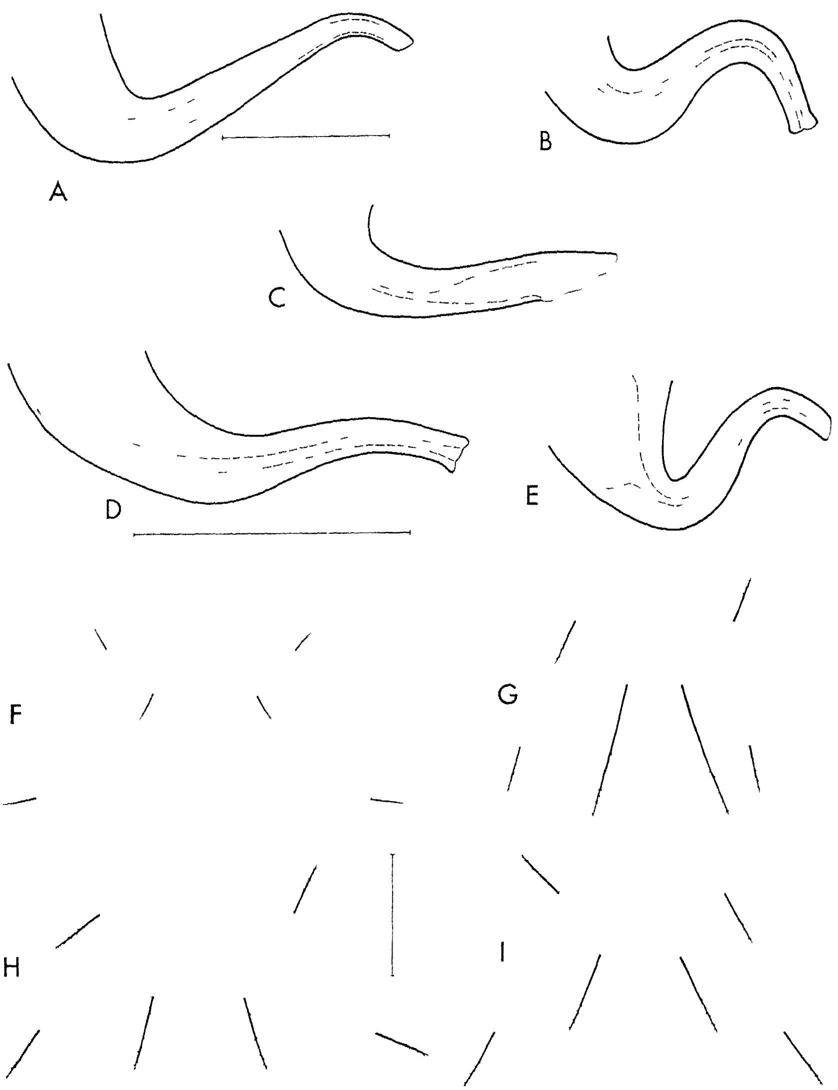

Fig. 3.—A-E. Aedeagi of (A) *Tyrophagus longior* (South Africa); (B) *T. putrescentiae* (Germany); (C) *T. similis* (California); (D) *T. neiswanderi* (Ohio); and (E) *T. mixtus* (New York). A, C. and E scale equals 15 microns. B and D scale equals 15 microns.

F-I. Dorsal setae d_1, d_2, and *la* of males of (F) *T. similis* (California); (G) *T. putrescentiae* (Ohio); (H) *T. longior* (France); and (I) *T. neiswanderi* (Ohio). F-I scale equals 50 microns.

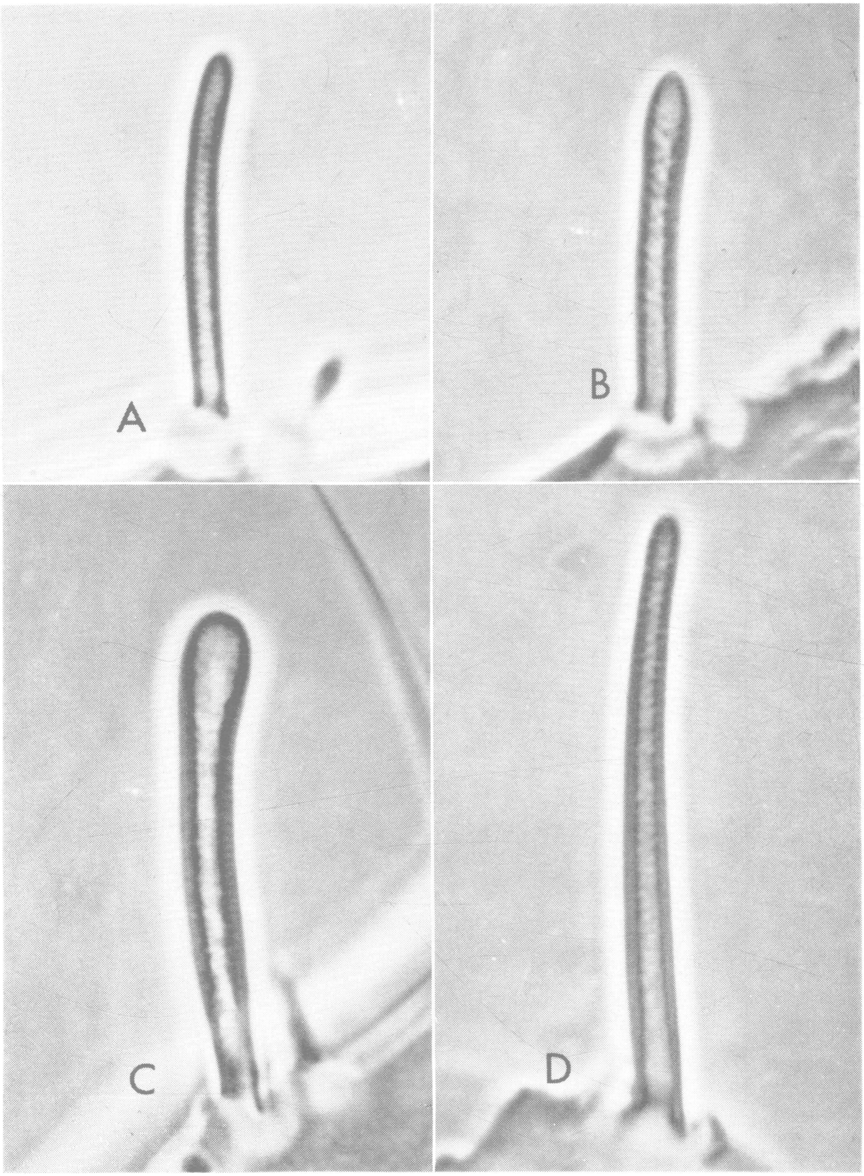

Fig. 4.—A-D. Photomicrographs of *omega*$_1$ I of males of (A) *Tyrophagus neiswanderi* (Ohio); (B) *T. putrescentiae* (Germany); (C) *T. similis* (California); and (D) *T. longior* (Japan); all to same scale.

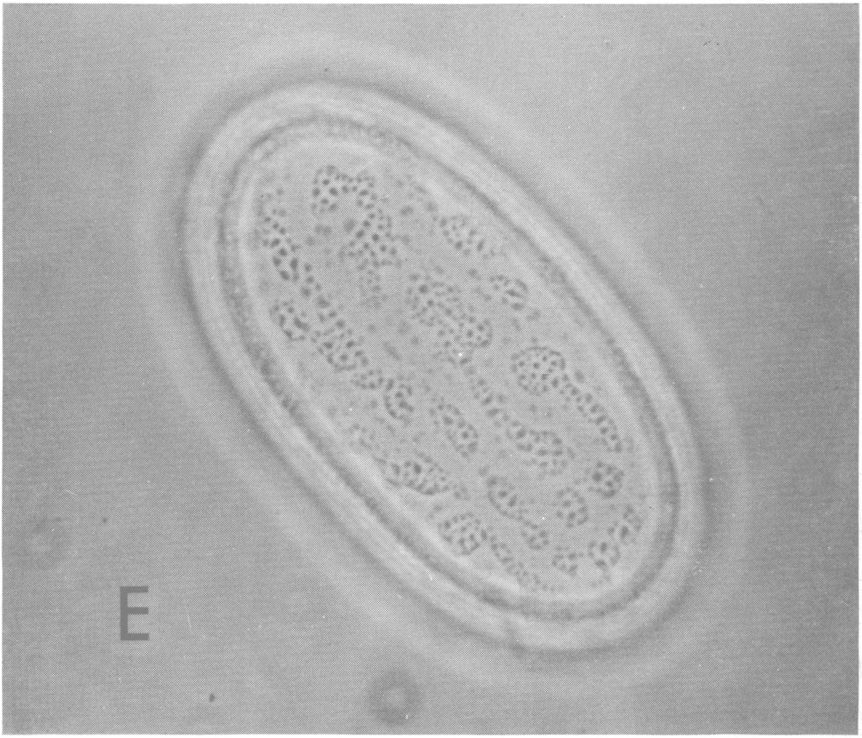

Fig. 4E.—Photomicrograph of recently laid egg of *T. neiswanderi*; to same scale as Fig. 4F.

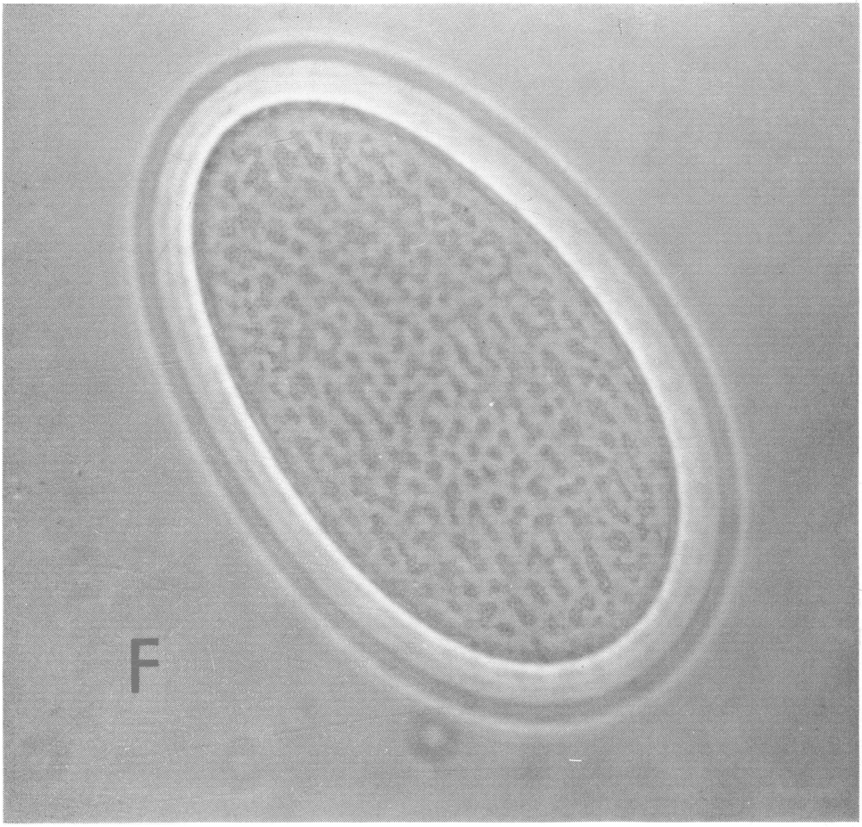

Fig. 4F.—Photomicrograph of recently laid egg of *T. putrescentiae;* to same scale as Fig. 4E.